Fall 2023 EE 445S Real-Time Digital Signal Processing Laboratory Prof. Evans

Homework #7

Channel Equalization and QAM Carrier Recovery

Assigned on Saturday, Nov. 11, 2023
Due by 11:59pm on Friday, Dec. 1, 2023

Homework submitted after 11:59pm will be subject to a penalty of 2 points per minute late.

Reading: Johnson, Sethares & Klein, Sections 6.6-6.8, 13.1-13.3 and 16.1-16.4

This assignment is intended to continue building our foundation for transmitter and receiver design.

Office hours for the teaching assistants and Prof. Evans; **bold** indicates a 30-minute timeslot.

Time Slot	***Monday***	***Tuesday***	***Wednesday***	***Thursday***	***Friday***
10:00am					
10:30am	**Evans (EER 1.318)**		**Evans (EER 1.318)**		
11:00 am	Evans (EER 1.318)		Evans (EER 1.318)		
12:00 pm					Evans coffee hours (EER Cafe)
1:00 pm					Evans coffee hours (EER Cafe)
2:00 pm		Jacobellis (Zoom)			
3:00 pm		**Jacobellis (Zoom)**	Evans (EER 6.882 & Zoom)		
3:30 pm			Evans (EER 6.882 & Zoom)	**Liu (Zoom)**	
4:00 pm			Evans (EER 6.882 & Zoom)	**Liu (Zoom)**	
4:30 pm			Evans (EER 6.882 & Zoom)	**Liu (Zoom)**	
5:00 pm			Evans (EER 6.882 & Zoom)	**Jacobellis (Zoom)**	**Liu (Zoom)**
5:30 pm			Evans (EER 6.882 & Zoom)	**Jacobellis (Zoom)**	**Liu (Zoom)**
6:00 pm				**Jacobellis (Zoom)**	**Liu (Zoom)**
6:30 pm					

Course Web site

NOTE: In your solutions, please put all work for problem 1 together, then all work for problem 2 together, etc.

Please submit any MATLAB code that you have written for the homework solution

As stated on the course descriptor, "Discussion of homework questions is encouraged. Please be sure to submit your own independent homework solution."

7.1 Channel Equalization Using a Least Squares FIR Design. 35 points.

Johnson, Sethares & Klein, problem 13.3, on page 279, but use a training signal `s` that is a pseudo-noise sequence of length `1023` concatenated 10 times and the channel impulse response

```
b = [1 -0.68 0.54 -0.25 0.32 -0.42 0.82 -0.9];
```

Plot magnitude and phase of the channel frequency response using the freqz command. The equalizer will seek to compensate the magnitude and phase response of the channel so that the cascade of the channel and equalizer would give (approximately) an ideal channel of a cascade of gain and delay.

Estimate the computational complexity and memory usage to design the channel equalizer coefficients when using a training sequence of m samples and an FIR equalizer of (n+1) coefficients.

Please read the online hints carefully.

7.2 Channel Equalization Using an Adaptive FIR Design. 35 points.

Johnson, Sethares & Klein, problem 13.9, on page 287, but use a training signal `s` that is a pseudo-noise sequence of length `1023` concatenated 10 times and the channel impulse response

```
b = [1 -0.68 0.54 -0.25 0.32 -0.42 0.82 -0.9];
```

Estimate the computational complexity and memory usage to design the channel equalizer coefficients when using a training sequence of m samples and an FIR equalizer of n coefficients.

Please read the online hints carefully.

7.3 QAM Carrier Recovery. 30 points.

Johnson, Sethares & Klein, problem 16.15, on page 371.

Please read the online hints carefully.